THE RESULTS OF PARTIAL AND COMPLETE OCCLUSION OF THE URETERS.

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FROM the writer's observation in practice and literature, it is probable that the ureter is occluded by ligature about three times in every 100 cases of vaginal or abdominal hysterectomy. The ureter may be tied for a few weeks, when, by the giving way of the ligature around the ureter, the kidney may naturally resume its secretion. It is more probable that the ligature will yield a little so that the ureteral lumen will be partially reopened, allowing the urine to flow through to a slight extent. Another method will be that the ligature will cut through the ureter, and a urinary fistula will follow. The writer is now fully convinced that many a ureter is tied off during the hysterectomy without the operator or patient having knowledge of it. It also appears to me that many of the deaths, especially in vaginal hysterectomy and some in abdominal hysterectomy, are entirely due to accidental ligature of *one* or *two* ureters. The ligature of one ureter in itself would not kill, but the very ureter leading to her best kidney may be ligated, and the patient is unable, with one kidney, containing deficient secreting apparatus, to withstand the emergency of the severe operation. The writer once witnessed a post-mortem on a woman in Vienna, where vaginal hysterectomy had been performed two days previously. The autopsy revealed one ureter tied, and as to the fate of the other ureter it was impossible to find out, but it was supposed to be intact. Now, in this case, it is probable that the kidney containing the main secretory power was made useless to the patient by occluding its ureter with a ligature. The other kidney being deficient in secreting substance, was unable to tide the woman over the ordeal of the trying operation. Deaths in hysterectomy have frequently appeared to me suspicious of something else than sepsis or shock. Death sometimes occurs with no apparent pathological cause, except that in some way or other the kidneys have been injured. Of course, it must never be forgotten that women, who have abdominal tumors, are very frequently diseased in the kidneys. In fact, autopsies on women who die from ovarian tumors as the result of operation for their removal, show chronic kidney disease in 75 per cent. of cases. Especially will a uterine myoma induce kidney disease by its irritation being emitted along the hypogastric plexus to the abdominal brain, where the forces are reorganized and transmitted to the kidney. The irritation on the kidney causes (a) increased secretion; (b) decreased secretion, or (c) disproportionate secretion. The result is renal vascular changes ending in tubular nephritis or interstitial nephrisis. Abdominal and pelvic tumors cause fatty degeneration of the heart. Abdominal and pelvic tumors cause fatty degeneration of the liver. Pelvic tumors frequently cause partial or complete occlusion of the ureters inducing hydronephrosis. It may then be expected that any woman requiring hysterectomy may be already suffering with kidney disease. So that all possible means should be employed to prevent any disaster from ureteral occlusion. It is estimated that each kidney contains 250,000 Malpighian tufts and seven miles of tubes. But disease may easily obliterate thousands of tufts and miles of tubes without giving evidence in which kidney the destruction exists. One kidney may be larger than the other, one may be absent. From a few of the above suggestions it is plain that the surgeon should be alert as to the ureters in hysterectomy.

From the importance of the subject to the gynæcologist, the writer undertook experiments on dogs' ureters in order to secure more definite knowledge of what became of a kidney when its ureter was ligated partially or completely.

The subject developed under several heads, as regards the results on the kidney: (1) When the ureter was occluded by ligature completely and forever. (2) When the ureter was partially occluded by ligature. (3) When the ligature cut through the ureter and the kidney resumed secretion.

Under another heading came the idea of what to do with a severed ureter. The following plan may be adopted: (a) Place the ureter in the abdominal wound. (b) Put it in the small intestine. (c) Put it in the large intestine. (d) Ligate it completely and stitch it to the wound or drop it into the abdominal cavity. (f) Extirpate the kidney. (g) If the ureter be divided close to its entrance into the bladder, it may be inserted into the top of the bladder by drawing the fundus of the bladder toward the kidney, and fixing it by sutures, so that the ureter would not be torn out during the emptying of the bladder or systole.

Ten experiments were performed on the ureter with the following results:

(Dr. J. F. Percy, of Galesburg, Ill, shared in six of the experiments.)

EXPERIMENT NO. 1.—Dog, weight fifteen pounds. Dr. Percy performed enterorrhaphy according to the author's stovepipe method. I then ligated the right ureter with Barber's linen thread, No. 40, by pushing an aneurism needle through the peritonæum, then around the ureter, and out through the peritonæum, and tying the thread. All the experiments were done by abdominal incision or by tying the ureter through the peritoneal cavity. The dog died of shock in twenty-six hours. The ureter was found full of urine. The ureter and kidney pelvis was so tensely full that the most delicate fluctuating wave could be produced by percussion. One would scarcely believe that a ureter could withstand such high pressure without rupture. The urine pressure was, no doubt, then above blood pressure. The ligation of the ureter in this experiment was simply secondary to the intestinal experiment which killed the dog. The ligation of the ureter, it is thought, had no cause of death in it.

EXPERIMENT NO. 2.—Dog, weight fifty pounds. Dr. Percy performed gastro-enterostomy with segmented rubber plates. I then ligated the right ureter with linen thread. Dog died in three days from fæcal fistula at site of operation, due to *crossing* the threads while tying them. The mistake caused the dog's death. In this case the ureter was ligated so loose that the lumen was only partially occluded and the urine trickled through. The right kidney was slightly larger than the left. The second error in this experiment was made by myself. I really thought I had tied the ureter sufficiently tight to occlude its lumen, but the autopsy proved otherwise. It plainly shows that *experience* is required in all abdominal surgery. Even three days of partial occlusion of the ureter had slightly enlarged the kidney—in short, had made a slight hydro-nephrosis. This is a suggestive lesson as to what abdominal and pelvic tumors may do.

Experiment No. 3.—Dog, weight fifteen pounds. Dr. Percy performed ileo-ileostomy with segmented rubber plates, completely severing the gut. I then tied the right ureter and closed the abdomen. Dog died in some fifty hours. Autopsy revealed the cause of death to be fæcal fistula. To my astonishment I found that I had not ligated the right ureter, but the right spermatic vein. Both Dr. Percy and myself felt sure that it was the ureter which passed over the aneurism needle. But I learned how the mistake was made. When the spermatic vein was pulled up it was kept on a stretch, and the dark venous blood did not flow through it while we kept it stretched, and then it appeared white and just like the ureter. Had I let the vein loose the blood would have coursed back through it, and it would have told its own tale. But yet, the mistaking the spermatic vein for the ureter has been made, and it is a blunder that may happen to the most elect.

Experiment No 4.—Dog, weight twelve pounds. Dr. Percy did circular enterorrhaphy according to Dr. Carnnell's method. I then tied the ureter. Dog died in three days. The autopsy revealed that the death was caused by (a) fæcal fistula; (b) the abdomen contained a considerable quantity of urine. The linen thread had cut into the ureter and allowed urinary leakage. It may be here stated that the deaths from intestinal operations must not be in any way related to the ligature of the ureter. They were separate labors for other objects.

Experiment No 5.—Dog, female, weight fifteen pounds. Dr. Percy performed ileo-ileostomy with segmented rubber plates, completely dividing the gut and applying an unsevered graft. Then with the aneurism needle I ligated the right ureter with Barber's linen thread, No. 40. The dog recovered well and appeared healthy and happy, eating and drinking. At the end of a month she began to lose a little flesh, but that was likely from close confinement in a small cage. At the end of six weeks she took a severe distemper, that then raged among dogs, and suddenly died. Autopsy revealed the anastomosis well healed, but the bimucous fistula had contracted to one-fourth of its original size, so that it was quite small at the end of six weeks. It had a lumen of about a third of an inch. The result of the ligature on the ureter was the following: The kidney was about three times the size of the other one. The ligature on the ureter had yielded a little, and the urine trickled through some. Six weeks of partial occlusion of the ureter had produced hydro-nephrosis. Had the occlusion been complete, the kidney would have atrophied.

EXPERIMENT No 6.—Dog, weight twenty pounds. Dr. Percy performed circular enterorrhaphy. I then tied the right ureter with linen thread (Barber's No. 40). The dog recovered, and he was kept for six months in a small cage. At the end of six months he was suffering from marasmus, probably on account of the close confinement. However, he ate and drank well. He was killed at the end of six months. The circular enterorrhaphy was well healed, but contracted to one-third of its original size. The right kidney, whose ureter was ligated, was shrunk to the size of the first joint of the thumb. It had shrunk to one-fifth of its original size. There was no trace of the ligature, except a white circular cicatrix around the ureter. The other kidney was slightly larger than normal. Complete absorption of the ligature had taken place. Complete occlusion of the ureter had produced atrophy of the kidney. We were not able to state whether the dog urinated more or less urine than at other times. In this case the kidney had secreted until its pelvis and ureter were full and up to blood pressure. Then the pressure had prevented further secretion and the glomeruli gradually shrank. The atrophy of this kidney was enormous for six months. It shows how quickly an organ will die if it is not used.

CONCLUSIONS AND RESULTS.

(1) Complete occlusion of the ureter produces atrophy of the kidney (in my experiments in a few months).

(2) Partial occlusion of the ureter produces hydro-nephrosis. The kidney cavity dilates and its walls thin.

(3) The kidney will bear complete occlusion for some weeks, and then resume its function after the obstruction and pressure are removed. The resumption of kidney secretion after weeks of complete obstruction will occur. I know of a lady whose ureter was ligated for six weeks, after which secretion resumed on removal of the ligature.

(4) The urine secretes until the pressure of the secreted urine is higher than blood pressure. The high pressure prevents circulation in the glomeruli.

(5) The ligature is apt to cut through the ureter wall and produce a urinary fistula.

(6) The ligature on the ureter is very apt to yield a little and allow the urine to trickle through in such cases and in hydro-nephrosis. Two ligatures should be thrown around the ureters at some distance from each other.

(7) It is probable that three ureters are tied in each 100 cases of hysterectomy.

(8) No doubt many ureters are tied and no knowledge of it exists.

(9) Severed ureters should not be put into the small bowel, as active peristalsis prevents healing. With me four carefully performed experiments of putting the ureter into the small intestine proved fatal from peritonitis.

(10) It has been asserted that the irritation of a ligature on one ureter will produce suppression of the secretion of the other kidney. Experiments disprove this assertion. When a patient dies from ligature of one ureter it is likely the other kidney is defective from disease and not reflex action.

(11) Man has double the amount of kidney required for ordinary use, but when an emergency arises he needs both kidneys. A man with one kidney is apt to die with pneumonia or other acute diseases.